The Effect of Incidental Appendectomy on Long Term Morbidity and Mortality

By

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Introduction

Appendectomies are one of the most common surgical procedures performed in the United States and involve the surgical removal of the appendix. Most have traditionally been performed in the presence of acute appendicitis, though the number of incidental appendectomies has risen. In the 2000s the rate of patients presenting with perforations had decreased compared to the previous few decades; however, the number of appendectomies had increased.[1] The current rate of procedures performed is around 97 per 100,000 people in a year.[2] The cause for decreased perforations is likely multifactorial. Acute appendicitis does not necessarily progress to a perforation and may be self-limiting. Current diagnostic methods such as computed tomography have a much greater sensitivity than those in the past, and patients with mild symptoms that may have previously been overlooked and would spontaneously resolve are now receiving operations. Laparoscopic surgery results in few complications and can now be conducted with relatively little risk.

This low surgical risk and the relatively common occurrence of appendicitis have given rise to more incidental appendectomies being performed during other abdominal surgeries. An incidental appendectomy is defined as the surgical removal of a healthy appendix during a surgical procedure unrelated to appendicitis. The justification for an incidental appendectomy is made by comparing the risk to the patient against both the benefit in the ease of performing an appendectomy and the high potential of a person presenting with appendicitis in the future. Incidental appendectomies are recommended in younger patients due to the higher likelihood of developing appendicitis while young, and providing the patient the maximum amount of time to potentially benefit from the procedure.[3] Additionally, incidental appendectomies performed during gynecological surgery have been found to be therapeutic for women with chronic right lower quadrant pain, and to narrow the differential diagnosis of recurrent right lower quadrant pain.[4] In general, incidental appendectomies occur during gynecological, urological, or trauma surgeries. New theories into the function of the appendix does raise a question which will be addressed herein. *Does an incidental appendectomy in patients undergoing abdominal surgery for other conditions decrease long-term morbidity and mortality*? Common complications encountered during all surgical procedures include bleeding, infection, and damage to surrounding tissues. These risks are theoretically minimized if an operation was already being performed in close proximity to the right lower quadrant, but this assumption may be incorrect. Also, there is the theory that appendectomies have been associated with long-term complications such as Clostridium difficile infections (CDI) due to an altering of the intestinal biome.[5] CDIs are a common and potentially fatal complication that occur frequently in health care facilities. Currently, C. difficile is the leading cause for diarrhea due to prior antibiotic use and in almost all patients with pseudomembranous colitis with prior antibiotic use.[6]

Many studies advocating the safety of incidental appendectomies refer primarily to the initial complications from surgery such as bleeding, infection, and damage to surrounding tissue, and do not focus on long-term risks. Incidental appendectomies may be beneficial, but the long-term consequences should be appropriately assessed prior to making any decision.

Epidemiology

The goal of an incidental appendectomy is to prevent the occurrence and potential complications associated with appendicitis**.** The risks and occurrence rate of appendicitis should be evaluated to determine the need for this procedure. Current estimates for population rates of appendicitis can be difficult to determine. The primary reason is that most epidemiological studies rely on ICD codes, but those do not have the accuracy of a pathology review which would show that up to 12% of appendectomies reveal a healthy appendix.[7] However, a total appendicitis rate (perforated and non-perforated) falls around 100 incidences per 100,000 people with perforation making up approximately 20% of those cases.[8] Demographically, the highest incident rate was; by age, patients 10-19 years old (23.3 per 100,000); by ethnicity, Caucasian populations (1.5 times higher); and by gender, a lifetime incidence of 8.6% for males and 6.7% for females.[9]

Pathophysiology

The vermiform appendix can be considered a true diverticulum located at the base of the cecum where the taenia coli merge. The orientation of the appendix and even its position can vary leading to a range of appendicitis presentations. The true function of the appendix is still debated and theories range from the appendix being a vestigial organ with no purpose, to an organ providing housing for beneficial gut bacterial flora, which can repopulate the intestine should the natural biome be altered. The most common cause of appendicitis, particularly in younger populations, is an obstruction of the appendiceal lumen which can become blocked by fecal material, lymphoid hyperplasia, or undigested food.[10] Once obstructed, an overgrowth of intraluminal bacteria can occur resulting in inflammation. Bacteria isolated from patients with acute appendicitis were primarily E. coli, with Klebsiella pneumonia, Streptococcus spp., Enterococcus spp. and Pseudomonas aeruginosa found in smaller numbers.[11] As time lapses, pressure and inflammation can increase in the lumen of the appendix, resulting in the common presentation of abdominal pain, anorexia, and fever. A normal appendix can typically produce 2-3 mL of mucus daily which continues in the case of an obstruction. This is why perforation can so rapidly occur after the onset of symptoms.[12] Should a perforation occur, the intestinal contents spill into the peritoneum and can rapidly lead to sepsis. If a perforation does not occur, increased pressure can lead to capillary blockage which may eventually lead to necrosis of the appendix.[12]

Methods

A search using PubMed, Scopus, and Google scholar was conducted for studies over the last 15 years. As CDIs have increased substantially over the last two decades, studies older than 15 years were disregarded as they would not reflect current trends. Searches included the terms appendectomy, appendicitis, clostridium, difficile, incidental, prophylactic, colectomy, colitis, recurrence. Systematic reviews or meta-analysis would have been preferred; however, none were found with the associated terms. Randomized control trials have been conducted regarding the risks of incidental appendectomies, but these only assessed short term risks. In the end, several retrospective analyses were the only research studies involving long term complications that could be found. Retrospective analyses were assessed for bias using the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, while case-control studies were assessed using the NIH Quality Assessment of Case-Control Studies.[13] Completed assessments for each study are provided in the appendices.

Results

Short term morbidity and mortality of incidental appendectomies

Many studies have been conducted to determine the safety of performing incidental appendectomies during otherwise routine abdominal surgeries. Four recent studies have found that there was no immediate statistically significant impact from incidental appendectomies.[14–16] However, one retrospective analysis did reveal an increase in post-operative infection rates.[17] The fours studies which found no negative impact were concerned primarily with the effect on morbidity and mortality immediately after surgery. Any potential downside is then weighed against the probability of the patient having appendicitis in the future to determine whether incidental appendectomies should be recommended. Overall, a systematic review of incidental pediatric appendectomies found support for incidental appendectomies in combination with certain procedures.[18] The largest benefit came from gynecological surgery and during surgical repair of intestinal malrotation. However, these studies exclusively focused on short term complications. An additional review of 997 hospitals in 37 states also found appendectomies to have the lowest risk of CDIs compared to other surgical procedures during hospitalization at a rate of 0.20%.[19] While potentially important in the short term, other studies have shown a different relationship between CDIs and appendectomies over the long term.

C. difficile recurrence

Appendectomies have been suspected to be a risk factor for CDI recurrence due to the role the appendix may play in the immune system. A retrospective study was performed on 254 patients with a known CDI recurrence and appendix status.[20] A CDI recurrence was defined in this study as diarrhea and a positive C. difficile toxin assay after a previous infection within 8 weeks. This study found that possession of an appendix ($P < .0001$; adjusted relative risk, 0.398; 95% CI, 0.262–0.605) and an age older than 60 years ($P = .0280$; adjusted relative risk, 2.44; 95% CI, 1.10–5.41) were two of the most important factors observed that impacted whether an infection would recur. The study was found to be well developed with low likelihood of bias based on the NIH assessment, but some flaws were present (table 1). The sample population was greater than 50% of the possible patients who would have been eligible, but the method of selection may have altered the results. Patients were selected based on the combination of known appendix status primarily through CT and C. difficile recurrence. It is possible a confounding variable exists between these two groups that was not properly assessed. For example, those requiring a CT for an unrelated reason may be in poorer health or have additional comorbidities which increases the likelihood of a C. difficile recurrence. Additionally, the population from the one hospital in the study may not adequately reflect the larger population.

A second retrospective study involved selecting patients from one hospital in Olmsted County, Minnesota from a period of 1991-2005.[21] A records review found 355 CDI cases of which 43 had prior appendectomies. On analysis, a history of prior appendectomy had no statistically significant difference in treatment failure (OR 0.9, 95 % CI 0.4 – 1.9, P=0.77), the development of severe CDI (OR 0.6, 95 % CI 0.3 – 1.4, P=0.26), severe-complicated CDI (OR 0.8, 95% CI 0.2 – 2.8, P=0.76), or recurrent CDI (OR 0.9, 95 % CI 0.5 – 1.9, P = 0.93) from those with no history. Of secondary interest, this study found the average onset of CDI post appendectomy in these patients to be 22.5 years. Using the NIH guidelines, this study was found to have few deficiencies or biases that would bring the results into question (table 2). However, there is the possibility of selection bias in this study as historical appendectomy could only be determined through chart review.

Clostridium difficile infection occurrence and severity

A retrospective chart review of 104 patients diagnosed with CDIs at a military hospital attempted to find a relationship between prior appendectomies and CDI occurrence or increased severity in infection.[22] The investigators stratified the patients into 6 subcategories of increasing severity. Overall no relationship was found linking severity to prior surgery. While not statistically significant, it was found that the frequency of CDIs was decreased in those with prior appendectomies. This study did have several limitations (Table 3). Patients ultimately only fell into three of the categories, two of which were separated by patient subjectivity (mild to severe diarrhea). This subjectivity, in combination with a small patient population, means the results could have been drastically skewed by a small number of patients having their symptoms misinterpreted.

A separate case-control study found similar results.[23] The goal was to determine whether an appendix provided any protection from CDIs. This was performed at one location over a two year period.

All patients who underwent C. difficile testing were selected, yielding 836 subjects of which 136 tested positive. Among the 136 cases, 27 had prior appendectomies (19.9%). Of the 121 who tested negative, 38 had a prior appendectomy (31.4%). The difference in appendectomy rates was found to be 11.6% (95% C.I.: -21.6% to -0.9%). This study may have had issues with selection bias (table 4). The study makes no mention of whether blind testing (which dictated patient grouping) was performed. Appendix status was also determined through patient history, which could be inaccurate. Finally, C. difficile status was determined using Toxin A & B EIA, which the authors admit may have a potentially high false positive rate.

Clostridium difficile infection resulting in colectomy

A retrospective analysis was performed at one hospital location looking at CDIs of 507 patients.[24] The severity of infection was compared between those who had prior appendectomies and those who had not. Of those with an intact appendix, 5.2% had a severe enough infection to warrant a colectomy, compared to 10.9% in those without an appendix. The conclusion reached is that a prior appendectomy increases the severity of a CDI (P = .03; 95% confidence interval [CI], 1.1 to 4.7; OR = 2.3). The authors found that these results apply similarly regardless of gender. The study is a quality source according to the NIH guidelines (Table 5), but it has other limitations. Approximately 90% of the sample population was over the age of 40 (456/507), and the authors mention that this could have contaminated the results. Additionally, there were no set guidelines on when a surgeon must perform a colectomy, making this result somewhat imprecise as a measure of infection severity. Finally, there is the possibility of recall bias being an issue as the appendectomy history of some subjects was based on a subject interview.

A different review found similar results after examining 55 pathological specimens from total colectomies of patients with pseudomembranous colitis consistent with CDI.[25] It was found that forty-nine percent (22/45 cases) had a prior appendectomy (95%CI: 0.350-0.630, 99%CI: 0.311-0.670). They were not able to find any statistically significant relationship between a prior appendectomy and mortality or CDI severity. No significant bias was found using the NIH guidelines (Table 6). A limitation is that a control group was not possible, so the conclusion the authors found was based on the comparison of the rate of appendectomies found in this study (49%) to the national average of 17.9%[9]. The authors justify their conclusion despite the lack of control due to the large statistical difference. The results of this study are questionable due to the small sample size.

Discussion

Incidental appendectomies were shown to be safe in the short term through multiple studies.[14–16] In addition, they were found to have one of the lowest immediate post-operative occurrence rates for CDI in any surgical procedure.[19] The safety of appendectomies weighed against the incident rate of appendicitis has been thought to justify the incidental appendectomy. While significant research has been conducted on short term complications, long term complications are still an unknown. With regards to CDI, the primary questions involve whether the appendix has a role in C. difficile occurrence, severity, or recurrence.

The results of whether CDI recurrence was increased in those with appendectomies were mixed. Im et al. (2011) found an increase in recurrence (Table 7) while Khanna et al. (2013) did not (Table 8). While both have issues with selection bias, Im et al. (2011) did not rely exclusively on patient charts to determine the surgical status of its subjects. While the impact of this is unknown, it does lend their argument more weight. Overall, this strengthens the conclusion that the appendix provides some manner of protection for C. difficile recurrence. It has been proposed that the appendix provides a natural reservoir of healthy bacteria that can restore the natural flora after a CDI. However, the argument against this is that an appendix could harbor Clostridium post infections and therefore actually increase the risk of a recurrence. Another possibility is that the appendix provides some protective measure in terms of immune function.

The results of other studies do show a possibility of increased severity of CDI for those with prior appendectomies. Ward et al. (2013) show no correlation between the appendix and CDI severity (Table 9), but their definition of severity did not specify infection necessitating colectomy. Yong et al. (2015) and Clanton et al. (2013) show a correlation could not be ascertained between the severity of an infection and prior appendectomy; however, a colectomy was required about twice as often in those without an appendix (Table 10 and 11). This could be due to a number of reasons. Guidelines for colectomies are not completely consistent between locations, which means severity while be in part subjectively judged by the surgeon conducting the procedure. However, these patients had a presentation significant enough to warrant a colectomy implying an illness of some severity. This lends support to the idea of the appendix playing some role in the gastric systems immune response.

Conclusion

In summation, the findings from these studies do not appear to coalesce into a clear picture of how the appendix relates to CDIs. Overall it appears that an appendectomy decreases the long-term occurrence of CDIs postoperatively; however, an appendectomy may increase the severity of an infection if it does occur and could increase the likelihood of a colectomy being required. The effect on mortality is not known. It should be noted that these findings are based heavily on retrospective analyses and more information is needed. There is not enough current research to answer the question of whether incidental appendectomies put patients at risk for long term complications. CDIs are increasingly prevalent and represent a high burden on the health care system. In 2009 there were approximately 453,000 infections and 29,000 deaths associated with Clostridium difficile.[19] The studies evaluated do show the possibility of a correlation between what is considered a relatively safe surgical procedure and complications later on. Due to the number of incidental appendectomies performed, more research is justified in determining their long term effects.

Appendix

Table 1

Quality Assessment of Controlled Intervention Studies **Im, et al. The appendix may protect against *Clostridium difficile* recurrence.**			
Criteria	**Yes**	**No**	**Other(CD,NR,NA)**
1. Was the research question or objective in this paper clearly stated?	X		
2. Was the study population clearly specified and defined?	X		
3. Was the participation rate of eligible persons at least 50%?	X		
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	X		
5. Was a sample size justification, power description, or variance and effect estimates provided?		X	
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	X		
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	X		
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?			NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
10. Was the exposure(s) assessed more than once over time?			NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
12. Were the outcome assessors blinded to the exposure status of participants?			NR
13. Was loss to follow-up after baseline 20% or less?			NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	X		
Quality Rating (**Good, Fair, or Poor)**	Good		

Table 2

Quality Assessment of Controlled Intervention Studies **Khanna et al, Appendectomy is not associated with adverse outcomes in *Clostridium difficile* infection: a population-based study.**			
Criteria	**Yes**	**No**	**Other(CD,NR,NA)**
1. Was the research question or objective in this paper clearly stated?	X		
2. Was the study population clearly specified and defined?	X		
3. Was the participation rate of eligible persons at least 50%?	X		
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	X		
5. Was a sample size justification, power description, or variance and effect estimates provided?		X	
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	X		
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	X		
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?			NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
10. Was the exposure(s) assessed more than once over time?			NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
12. Were the outcome assessors blinded to the exposure status of participants?			NR
13. Was loss to follow-up after baseline 20% or less?			NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	X		
Quality Rating (**Good, Fair, or Poor)**	Good		

Table 3

Quality Assessment of Controlled Intervention Studies **Ward et al, *Clostridium difficile* Colitis: Is Severity Increased with Previous Appendectomy?**			
Criteria	**Yes**	**No**	**Other(CD,NR,NA)**
1. Was the research question or objective in this paper clearly stated?	X		
2. Was the study population clearly specified and defined?	X		
3. Was the participation rate of eligible persons at least 50%?	X		
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	X		
5. Was a sample size justification, power description, or variance and effect estimates provided?		X	
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	X		
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?			CD
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	X		
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
10. Was the exposure(s) assessed more than once over time?			NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
12. Were the outcome assessors blinded to the exposure status of participants?			NR
13. Was loss to follow-up after baseline 20% or less?			NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	X		
Quality Rating (**Good, Fair, or Poor)**	Fair		

Table 4

Quality Assessment of Controlled Intervention Studies **Merchant, et al. Association Between Appendectomy and *Clostridium difficile* Infection**			
Criteria	**Yes**	**No**	**Other(CD,NR,NA)**
1. Was the research question or objective in this paper clearly stated and appropriate?	X		
2. Was the study population clearly specified and defined?	X		
3. Did the authors include a sample size justification?	X		
4. Were controls selected or recruited from the same or similar population that gave rise to the cases (including the same timeframe)?	X		
5. Were the definitions, inclusion and exclusion criteria, algorithms or processes used to identify or select cases and controls valid, reliable, and implemented consistently across all study participants?	X		
6. Were the cases clearly defined and differentiated from controls?	X		
7. If less than 100 percent of eligible cases and/or controls were selected for the study, were the cases and/or controls randomly selected from those eligible?			NA
8. Was there use of concurrent controls?	X		
9. Were the investigators able to confirm that the exposure/risk occurred prior to the development of the condition or event that defined a participant as a case?	X		
10. Were the measures of exposure/risk clearly defined, valid, reliable, and implemented consistently (including the same time period) across all study participants?	X		
11. Were the assessors of exposure/risk blinded to the case or control status of participants?			NR
12. Were key potential confounding variables measured and adjusted statistically in the analyses? If matching was used, did the investigators account for matching during study analysis?	X		
Quality Rating (**Good, Fair, or Poor)**	Fair		

Table 5

Quality Assessment of Controlled Intervention Studies **Yong et al, Appendectomy: a risk factor for colectomy in patients with *Clostridium difficile***			
Criteria	**Yes**	**No**	**Other(CD,NR,NA)**
1. Was the research question or objective in this paper clearly stated?	X		
2. Was the study population clearly specified and defined?	X		
3. Was the participation rate of eligible persons at least 50%?	X		
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	X		
5. Was a sample size justification, power description, or variance and effect estimates provided?		X	
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	X		
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?			CD
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?			NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
10. Was the exposure(s) assessed more than once over time?			NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
12. Were the outcome assessors blinded to the exposure status of participants?			NR
13. Was loss to follow-up after baseline 20% or less?			NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	X		
Quality Rating (**Good, Fair, or Poor)**	Good		

Table 6

Quality Assessment of Controlled Intervention Studies Clanton et al, Fulminant *Clostridium difficile* infection: An association with prior appendectomy?			
Criteria	**Yes**	**No**	**Other(CD,NR,NA)**
1. Was the research question or objective in this paper clearly stated?	X		
2. Was the study population clearly specified and defined?	X		
3. Was the participation rate of eligible persons at least 50%?	X		
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	X		
5. Was a sample size justification, power description, or variance and effect estimates provided?		X	
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	X		
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?			CD
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?			NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
10. Was the exposure(s) assessed more than once over time?			NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	X		
12. Were the outcome assessors blinded to the exposure status of participants?			NA
13. Was loss to follow-up after baseline 20% or less?			NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	X		
Quality Rating (**Good, Fair, or Poor)**	Good		

Table 7

Im, et al. (2011). Variables associated with C. difficile recurrence

	Adjusted relative risk	95% CI	P value
Appendix present	0.398	30.262-0.605	< .0001
Age > 60	2.44	1.10-5.41	0.0280

Table 8

Khanna, et al. (2013). Appendectomy effect on C. difficile severity and recurrence

	Treatment failure	Development of severe CDI	Development of sev/comp CDI	Development of recurrent CDI
Odds ratio and CI when comparing prior appendectomy to no appendectomy	OR 0.9, 95% CI 0.4-1.9, P = 0.77	OR 0.6, 95% CI 0.3-1.4, P = 0.26	OR 0.8, 95% CI 0.2-2.8, P = 0.76	OR 0.9, 95% CI 0.5-1.9, P = 0.937

Table 9

Ward, et al. (2013). Relationship between the appendix and C. difficile severity

	Tested pos. for C. difficile (50)	Tested neg. for C. difficile (52)	Mild symptoms (33)	Severe symptoms (59)	Developed colitis (6)
W/ prior appendectomy n = 22	7 (31.8%)	14 (63.6%)	7 (31.8%)	10 (45.5%)	2 (9.1%)
W/o appendectomy n = 82	43 (52.4%)	38 (46.3%)	26 (31.7%)	49 (59.8%)	4 (4.8%)

Table 10

Yong, et al. (2015). Relationship between the appendix and C. difficile requiring colectomy

	Total sample n = 507	Developed CDI requiring colectomy
W/ prior appendectomy	119 (23.5%)	13 (10.9%)
W/o appendectomy	388 (76.5%)	20 (5.2%)

Table 11

Clanton, et al. (2013). Relationship between the appendix and C. difficile requiring colectomy

	Total colectomy population n = 55	Confirmed CDI
W/ prior appendectomy	31 (56.4%)	22 (48.9%)

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